Date. 1874.	Satellite.	Phenomenon.	G.M.T. h	m	s	Remarks.
	I.	Ec. R. first seen	10	31	0	Good.
		fully bright	10	34	0	Uncertain.
April 23	I.	Tr. I. first contact	12	10	0	Pretty good.
		bisection	12	12	0	Pretty good.
		last contact	12	13	30	Perhaps not good.
May 1	I.	Oc. D. first contact	11	9	30	Fair.
		bisection	11	11	0	Not reliable.
		disappeared	11	12	30	Good.
May 2	I.	Tr. I. first contact	8	26	3	Pretty good.
		bisection	8	28	5	Not reliable.
		int. contact	8	30	2	Very fair; cloudy.
	I.	Sh. I. bisection	9	25	0	Not good; too much cloud.
			9	27	0	Not good.
	I.	Tr. E. inner contact	10	41	0	Cloudy; uncertain.
		bisection	10	43	2	Cloudy; uncertain.
		ext. contact	10	44	5	Pretty good.
May 8	I.	Occ. D. first contact	12	58	0	Planet very low; bad definition.
		disappeared	13	0	0	Observation not good.
May 10	I.	Ec. R. first seen	10	44	30	An uncertain observation; cloudy
May 17	I.	Occ. D. first contact	9	15	1·5	Good.
		bisection	9	17	0	Uncertain.
		disappeared	9	18	30	Very good.
June 8	III.	Occ. D. first contact	8	49	0	Fairly good.
		bisection	8	54	0	Uncertain.
		disappeared	8	57	5	Very good.
June 10	I.	Tr. E. inner contact	8	54	0	Not good.
		bisection	8	56	0	Not good.
		last contact	8	58	30	Fairly good; possibly early.

On a New Astrometer. By E. B. Knobel, Esq.

Having been for some time engaged in a work which necessitates the determination of the relative magnitudes of Telescopic Stars, I have been led to devise the following contrivance for doing so.

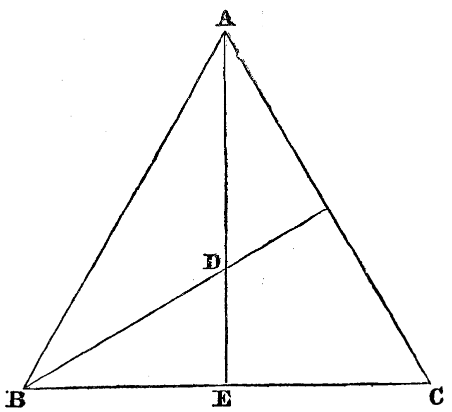
It is a well-known fact that an equatoreal triangular aperture gives very good definition. Sir John Herschel says,* "The triangular aperture," or diaphragm, which admits the light

* *Cape Observations*, p. xvi.

through an opening concentric with the speculum in the form of an Equilateral Triangle, to whose use as a means of separating close double stars continual reference will be found in the following pages, affords an elegant example of this theory,* in the sharpness of the central disk which it produces, and the absence of all appendages other than six perfectly straight delicate rays running off at angles of 60° from the disk. In a letter addressed, December 24, 1834, to the late Captain B. Hall, of which I retain a copy, I find an observation of *Canopus*, with such an aperture, and a magnifying power of 1,200, thus described:—"The disk is an *exact circle*, and the six rays which such an aperture always gives, are perfectly straight, delicate, brilliant lines, like brightly illuminated threads running far out beyond the field of view, and (what is singular) capable of being followed, like real appendages to the star, long after the star itself had left the field. In examining stars to see if they are close double, I always apply the triangular aperture. It reduces the disk to hardly more than a third of their size, and gives them a clearness and perfection incredible without trial." †

My contrivance is simply an equilateral triangle aperture, which can be increased or diminished within the limits of the triangle inscribed in the telescope tube and zero.

It is based upon the simple mathematical principle that sine $30°=\frac{1}{2}$. If ABC be an equilateral triangle, and the centre D of the triangle be found by bisecting two of the angles; then the perpendicular DE is to the hypothenuse DB as 1 to 2; and as DB=AD, therefore DE $=\frac{1}{2}$ AD.



I have therefore constructed an equilateral triangle of two plates: one containing the angle BAC, and the other forming the base of the triangle. These two plates are connected by a screw-shaft, the peculiarity of which is, that the lower portion, which carries the socket of the Base-plate, is a *left-handed* screw, and the upper part of the shaft, carrying the Angle-plate, is a *right-handed* screw. Moreover, the pitch of the lower screw, which I may call the Base-screw, is exactly $\frac{1}{2}$ that of the upper or Angle-screw.

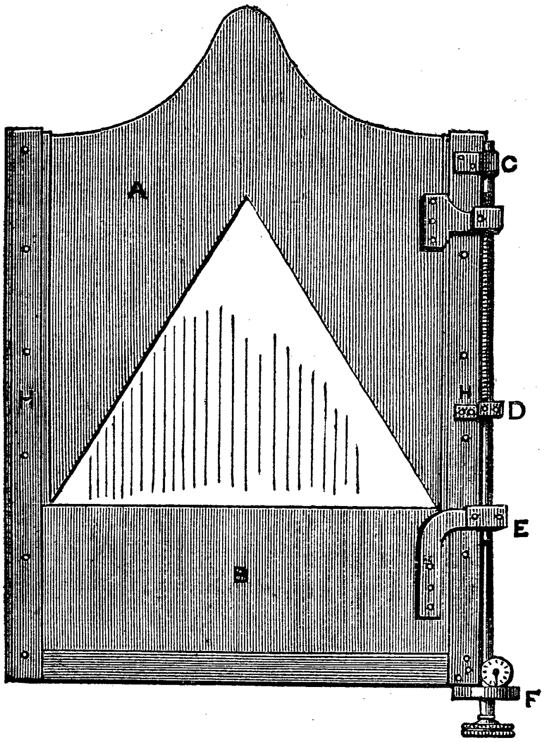
It will be seen, therefore, that, in consequence of the screws being opposite in kind, the rotation of the shaft in one direction

* The optical Law of Interferences.

† "Limiting the aperture of the object-glass or speculum to its inscribed equilateral triangle is often useful in stellar observation, as it reduces the 'spurious disks' of stars to very small points."—Herschel on "The Telescope," *Ency. Brit.*

will cause the plates to either approach or recede from each other, whilst the pitch of the screws being as 1 to 2, the rate of motion of the plates will be in that proportion. By these means the aperture is kept always equilateral and concentric with the mirror.

The drawing needs little description. A is the Angle-plate, which slides under B the Base-plate, both working between guides HH on each side. CF is the screw-shaft, of which the part CD is the right-handed screw $\frac{1}{20}$ inch pitch, and DE is a left-handed screw $\frac{1}{40}$ inch pitch; F is an ordinary micrometer head.



The instrument has been made for me by Mr. Browning, and it thoroughly fulfils all the required conditions. The motion is quite smooth and easy; the concentricity of the triangle is practically perfect, and I consider it a piece of fine mechanical work, which does Mr. Browning the greatest credit.

To use the instrument, it is necessary to be able to determine the area of the aperture available for light. I have therefore had the base of the triangle graduated each way from the centre, which will at once give by inspection half the side of the triangle. The micrometer head, fitted on the shaft, will also give the side of the triangle still more accurately, whence the area will be obtained by the formula $\frac{\sqrt{3} \times \text{side}^2}{4}$.

My telescope being a Newtonian Reflector, this area *minus* the area of the circle of the plane gives the area available for

light. The aperture can thus be easily calculated down to the point where the sides of the triangle form tangents to the circle of the plane. But when the triangle is reduced so that the sides cut off segments of this circle, the calculation is rather more complicated. And here I have been much indebted to Mr. Gray for furnishing me with a simple formula for the calculation of the available aperture under these circumstances, which I beg to subjoin to this paper. Practically, however, the instrument will measure the versed size of the segment in terms of micrometer parts, and the radius of the circle being known, the area of the segment can be found by a table of Areas of Segments, such as that given in the *Encyclopædia Britannica* (Art. 'Mensuration').

The aperture can then be calculated from the formula:

Aperture = area of triangle − area of circle of plane + 3 area of segment.

The instrument fits readily on to the end of the telescope tube, and is conveniently accessible to the hand of the observer, and it is easy for him to gradually diminish the aperture to the extinction of a star's light, without moving his eye from the eye-piece.

In the last century Bailly proposed to determine the brightness of each star upon strict photometrical principles, and suggested that all stars should be observed with the same telescope, and that in every instance the aperture should be diminished until the star just ceased to be visible. Professor Grant, in his *History of Physical Astronomy*, says, that "this mode of determining the relative brightness of the stars is unexceptionable in point of theory, but practical difficulties have hitherto stood in the way of its adoption."

My Astrometer endeavours to comply with some of these conditions; and I therefore venture to express a hope that to those observers who take up this valuable but neglected branch of astronomy, and to those who study variable stars, it may be found not altogether useless.

The Heath, Stapenhill, Burton-on-Trent,
1874, *December* 10.

An investigation of the area of the effective aperture was furnished by Mr. P. Gray. We have an equilateral triangle, the side of which is $= s$, and a concentric circle radius $= r$, wholly interior to the triangle, or else cutting its three sides; in the former case, the aperture in question is

= area of triangle − area of circle;

in the latter case, it is

= area of triangle − area of portion within the triangle,

viz. this is

= area of triangle − area of circle + area of the 3 segments outside the triangle. The area of the triangle is $\frac{s^2\sqrt{3}}{4}$, that of the circle is πr^2; and if 2θ be the angle which the segment subtends at the centre of the circle, then area of segment $= r^2\theta - r^2 \sin\theta\cos\theta, = \frac{1}{2}r^2(2\theta - \sin 2\theta)$. But we have $\cos\theta = \frac{p}{r}$, if p is the perpendicular from the centre of the circle on the side of the triangle, viz. this is $\frac{1}{3}$ perpendicular from vertex on opposite side, $= \frac{1}{3}s\frac{\sqrt{3}}{2}, = \frac{s}{2\sqrt{3}}$, that is, $\cos\theta = \frac{1}{2\sqrt{3}}\frac{s}{r}$, and therefore $\sin\theta = \sqrt{1 - \frac{1}{12}\frac{s^2}{r^2}}$. Hence, in the former case,

$$\text{Aperture} = \frac{s^2\sqrt{3}}{4} - \pi r^2;$$

in the latter case,

$$\text{Aperture} = \frac{s^2\sqrt{3}}{4} - \pi r^2 + \frac{3}{2}r^2\left\{2\cos^{-1}\frac{1}{2\sqrt{3}}\frac{s}{r} - \frac{1}{\sqrt{3}}\frac{s}{r}\sqrt{1 - \frac{1}{12}\frac{s^2}{r^2}}\right\};$$

or, what is the same thing,

$$= \frac{s^2\sqrt{3}}{4} - \pi r^2 + 3r^2\cos^{-1}\frac{1}{2\sqrt{3}}\frac{s}{r} - \frac{1}{4}s\sqrt{12r^2 - s^2}.$$

[Ed.]

Hyperbolical Elements of Comet I. 1845, *derived from* 244 *Observations. Osculation and Mean Eq.* 1845·0.

By Dr. W. Doberck.

T = 1845, Jan. 8, 4^h 1^m 41^s ± 2^m 26^s m. Par. T.

	°	′	″	″
π	91	19	55·9	±5·9
☊	336	44	25·9	±0·9
ι	46	51	0·8	±8·8
log q	9·956 7491			±0·000 0055
e	1·000 2467			±0·000 1047

Direct.

Col. Cooper's Observatory,
1874, *December.*